NOTIFICATION

No. 69/2022 Date : 18/06/2022

Subject : Implementation of new Syllabi of Semester VII & VIII of B.E. Electrical Engg., Electrical (Electronics & Power Engg.) and Electrical & Electronics Engg.(C.B.C.S.) as per A.I.C.T.E. Model Curriculum…

It is notified for general information of all concerned that the authorities of the University have accepted to implement new Syllabi of Semester VII & VIII of B.E. (Electrical Engg.), Electrical (Electronics & Power) and Electrical & Electronics Engineering (C.B.C.S.) as per A.I.C.T.E. Model Curriculum to be implemented from the academic session 2022-23 onwards as per ñ**Appendix – A**ò as given below:

Sd/-
(Dr.T.R.Deshmukh)
Registrar

ñ**Appendix A**ò

Syllabus of VII & VIII Semester B.E Electrical (Electronics & Power) (C.B.C.S.)

SEVENTH SEMESTER

7EP01 POWER SYSTEM-II

Course Outcomes:

After successful completion of this course, student will be able to:

1. Explain the basic Concept of Fault Analysis in Electrical systems.
2. Analyze the different types of symmetrical and Unsymmetrical Faults in Electric Power System.
3. Explain the concept of Power System Stability and synchronous machine parameter determination.
4. Analyze the steady state stability of system.
5. Assess transient state stability of two machine system.

Unit I: Basic Concepts: Symmetrical components Definition and choice, Alpha operator, transformation matrices, sequence components, power invariance, line and phase sequence quantities relations, three phase delta/star transformer bank- sequence voltages and currents relationship; power system elements ï sequence impedance and sequence networks; Various three phase transformer connections ï zero sequence rules;

Unit II: Symmetrical Fault Analysis: Symmetrical Fault Analysis Transmission line transients, three phase symmetrical short circuit at alternator terminals, Power system fault calculations, short circuit MVA, Current limiting reactors, ring system and tie bar system, Circuit breaker rating calculation.

Unit III: Unsymmetrical Fault Analysis: Unsymmetrical Fault Analysis L-G, L-L-G and L-L faults at unloaded generator terminals, Equivalent sequence network diagram, Fault impedance, Unsymmetrical faults through impedance, Power system faults loaded and unloaded conditions.

Unit IV: Fundamentals of Stability: Meaning of stability, Steady state, Transient and Dynamic stability limits; Three Phase Synchronous Machine-circuit representation, voltage equation and Parkôs Transformation; Reactance and Time Constants determination.

Unit V: Steady State Stability: Steady state stability limit-short transmission line, two machines system, Clarkeôs diagrams for system with and without loss, Conservative criterion, Synchronizing coefficients and Multi machine system. Short circuit ratio and automatic voltage regulator effects.

Unit VI: Transient State Stability: Transient state stability and equal area criterion, Swing equation and its point-by-point solution, Critical clearing angle and time. Type of faults, Grounding and high-speed re-closing effects, Stability improvement methods, and role of Digital Computers in stability studies.

BOOKS RECOMMENDED:

Text Books:

1. D. P. Kothari, I. J. Nagrath, ñPower System Engineeringò, TMH 3rd edition, 26th April 2019.
2. E W Kimbark, ñPower System Stabilityò, Vol.1 and 3, Dover Publications Inc., NewYork.
3. Prabha Kundur, ñPower System Stability & Controlò, TMH, 11th reprint 2011.

Reference Books:

1. L.P. Singh, ñComputer Aided Power System Operation and Dynamicsò, Wiley Eastern Ltd. New Delhi.
2. J.Nagrath and D.P.Kothari, ñModern Power System Analysisò, Tata Mc-Graw Hill Publishing Company, New Delhi.
3. N. V. Ramana, ñPower System Analysisò, PEARSON education, 2010.
4. Arthur R. Bergen, Vijay Vittal, ñPower System Analysisò, 2nd Edition, 2009, PEARSON Education.

7EP02 DIGITAL SIGNAL PROCESSING

Course Outcomes: After successful completion of this course, students will be able to:

1. Analyze the discrete time signals in time domain.
2. Analyze the discrete time systems using DTFT and DFT.
3. Apply the concept of Band pass sampling.
4. Design the structures of different types of digital filters.
5. Analyze the frequency response of various digital filters.
6. Apply the knowledge of multi-rate signal processing.

Unit I: Introduction to DSP, Frequency domain description of signals &systems, Discrete time sequences systems, Linearity unit sample response, Convolution, Time invariant system, Stability criteria for discrete time systems, Solutions of linear difference equations.

Unit II: Fourier Transform**:** Introduction to Fourier transform of Discrete Time Signal and its properties, Inverse Fourier transform, DFT and its properties, Circular convolution, Linear convolution from DFT, FFT, decimation in time and frequency algorithm.

Unit III: Sampling of Band pass signals, Representation of Band pass signals, sampling of Band pass signals, discrete time processing of continuous time signal; Analog to digital conversion-sample and hold, quantization and coding, analysis of quantization errors, oversampling of A/D converter; Digital to Analog conversion sample and hold, first order hold, linear interpolation with delay, oversampling of D/A converter.

Unit IV: Filter categories, Direct form I, Direct form II, Cascade and parallel structure for IIR and FIR Filter, Frequency sampling structures for F.I.R. filter, Steps in Filter Design, Design by Pole Zero Placements, FIR filter design by Windowing Method, Rectangular, Triangular and Blackman window

Unit V: Analog filter types, Butter worth, Elliptic filter, Specification and formulae to Decide to filter order, Methods to convert analog filter into IIR digital, Mapping of differential, Impulse Invariant, Bilinear, Matched Z transformation.

Unit VI: Multirate DSP and Introduction to DSP Processor, Decimation by a factor D, interpolation by a factor I, sampling rate conversion by a rational factor I/D, Filter Design & Implementation for sampling rate conversion, Multi stage Implementation of sampling rate conversion. General Architecture of DSP, Case Study of TMS320C67XX.

BOOKS RECOMMENDED:

Text Books:

1. J. G. Proakis and D. G. Manolakis, ñDigital Signal Processing: Principles, Algorithm and Applicationsò, (4th Edition), Prentice Hall, 2007
2. N. J. Fliege, ñMultirate Digital Signal Processing: Multirate Systems - Filter Banks ï Waveletsò, (1st Edition), John Wiley and Sons Ltd, 1999.

Reference Books:

1. S. K. Mitra, ñDigital Signal Processingò, 3rd Edition, TMH Edition.
2. Ifaeachor E.C, Jervis B. W., ñDigital Signal Processing: A Practical Approachò, Pearson Publication
3. S. K. Mitra, ñDigital Signal Processing: A Computer Based Approachò, McGraw Hill, 2011.

7EP03 ENTREPRENEURSHIP AND PROJECT MANAGEMENT

Course Outcomes: After successful completion of this course, students will be able to:

1. Understand the concept of entrepreneurship and its role in economic development.
2. Compare the various business model and select the most suitable.
3. Identify & formulate the project report and Source of finance for a project.
4. Estimate the cost, time & resources for the project work.

Unit I: Entrepreneurship: Introduction to Entrepreneurship, Meaning and concept of entrepreneurship, Need of Entrepreneurship, Types of Entrepreneurships-Social, For Profit, Not for Profit, the Evolution history of entrepreneurship development, role of entrepreneurship in economic development, Institutions/agencies for entrepreneurship development, future Scope of entrepreneurship, Entrepreneurial Ecosystem.

Unit II: Entrepreneur: Entrepreneur: Who? Why? How? the Attributes, skills/traits required to be an entrepreneur; Creative and Design Thinking, types of entrepreneurs. Myths and Realities about entrepreneurs, the entrepreneurial decision process, skill gap analysis, and Entrepreneurial models, entrepreneurial success stories, Pitching for Start-ups, Marketplace, Market space.

Unit III: Business Model & Business Organization: Types of Business Models; its importance, Business Plan: Importance, Guidelines and Contents, Specimen of a B-Plan and Feasibility Studies, pre- requisites from the perspective of investor. The importance and diversity of business model, components of an effective business model Canvas, Various form of business organization-sole proprietorship, partnership, corporations, Limited Liability Company.

Unit IV: Project Management: Basic concepts & Planning: Life Cycle of a Project. The Steps in managing a Project. International Standards (PMI, IPMA). Different types of projects: industrial, research and more. The role of the Project Manager. Terms of the Project Contract. Project Planning. Goals and Objectives of the Project. Owners and Stakeholder. The Work Breakdown Structure (WBS) to plan a project.

Unit V: Project identification & Evaluation: Selection - project formulation ï contents of a project report - planning commission, guidelines for formulating a project - specimen of a project report. Source of finance for a project - Institutional finance supporting projects, project evaluation - objectives - types - methods.

Unit VI: Time and Cost Management: Estimation of Time, Costs and Resources. Scheduling Project Work. Critical Path Method (CPM). Resource balancing. Defining Project Risks. Process to establish the project risk plan. Contingency Reserves. Risk Matrix Analysis. Project Control and Evaluation.

BOOKS RECOMMENDED:

Text Books:

1. S. S. Khanka, ñEntrepreneurial Developmentò, S. Chand and Company Limited, New Delhi, 2001.
2. Dr. C. B. Gupta, Dr. N.P. Srinivasan, ñEntrepreneurial Developmentò, Sultan Chand & Sons.

Reference Books:

1. S. Choudhury, ñProject Managementò, Tata McGraw Hill Education Private Limited, 2009.
2. Denis Lock, ñProject Managementò, Gower Publishing Company, USA.

7EP04 PROFESSIONAL ELECTIVE III
(i) WIND AND SOLAR SYSTEMS

Course Outcomes: After successful completion of this course, students will be able to:

1. Understand the energy scenario and the consequent growth of the power generation fromrenewable energy sources.
2. Understand the basic physics of wind and solar power generation.
3. Understand the power electronic interfaces for wind and solar generation.
4. Understand the issues related to the grid-integration of solar and wind energy systems.

Unit I: Physics of Wind Power: History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

Unit II: Wind Generator Topologies: Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters. Generator- Converter configurations, Converter Control.

Unit III: The Solar Resource: Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Unit IV: Solar Photovoltaic: Technologies-Amorphous, mono-crystalline, polycrystalline, V-I characteristics of a PV cell, PV model, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.

Unit V: Network Integration Issues: Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behaviour during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Unit VI: Solar Thermal Power Generation:
Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, Elementary analysis.

BOOKS RECOMMENDED:

Text Books:

1. T. Ackermann, ñWind Power in Power Systemsò, John Wiley and Sons Ltd., 2005.
2. S. P. Sukhatme, ñSolar Energy: Principles of Thermal Collection and Storageò, McGraw Hill, 1984.

References Books:

1. G. M. Masters, ñRenewable and Efficient Electric Power Systemsò, John Wiley and Sons, 2004.
2. H. Siegfried and R. Waddington, ñGrid integration of wind energy conversion systemsò, John Wileyand Sons Ltd., 2006.
3. G. N. Tiwari and M. K. Ghosal, ñRenewable Energy Applicationsò, Narosa Publications, 2004.
4. J. A. Duffie and W. A. Beckman, ñSolar Engineering of Thermal Processesò, John Wiley & Sons, 1991.

7EP04 PROFESSIONAL ELECTIVE – III
(ii) ELECTRICAL ESTIMATING & COSTING

Course Outcomes: After successful completion of this course, students will be able to:

1. Understand methods of installation and estimation of service connection.
2. Decide type of wiring, its estimation and costing for residential building.
3. Carry out electrification of commercial complex, factory unit installations.
4. Design & estimate for feeders & distributors.
5. Understand contract, tendering and work execution process.

Unit I: Electrical Installation: Classification of Electrical Installation, General requirement of Electrical Installation, Important definitions related to Installation, Service Connection: Concept of service connection, Types of service connection & their features, Methods of Installation of service connection, Estimation of service connection.

Unit II: Residential Building Electrification: Procedures for designing the circuits and deciding the number of circuits, Selection of type of wiring and rating of wires & cables, Earthing of Residential Installation, Estimate and cost Preparation of Residential Installation.

Unit III: Electrification of Commercial Installation: Concept of commercial Installation, differentiate between electrification of Residential and commercial Installation Deciding the size of cables, busbar and busbar chambers, earthing of the electrical Installation Selection of type wire, wiring system, preparation of detailed estimate and costing of commercial Installation.

Unit IV: Electrification of Factory Unit Installation: Concept of Industrial load, Concept of Motor wiring circuit, Important guidelines about power wiring and Motor wiring, Selection and rating of wire, cable size, Sequence to be followed to prepare estimate, preparations of detailed estimate and costing of small factory unit/workshop.

Unit V: Design &Estimate for Feeders & Distributors: Different schemes for feeders & distributors, estimates for different feeders & distributors, Distribution transformer, Deciding Size & location, Estimate for outdoor & indoor type distribution substation.

Unit VI: Contracts, Tenders and Execution: Tender and tender notices, Procedure for submission and opening tenders, Comparative statements, criteria for selecting contractors, General conditions in order form, Principles of Execution of works administrative approval, technical sanctions, Billing of executed work.

BOOKS RECOMMENDED:

Text Book: N. Alagappan S. Ekambaram, ñElectrical Estimating and Costingò, Tata Mc Graw Hill Publication, New Delhi.

Reference Books:

1. K. B. Raina, S. K. Bhattacharya, ñElectrical Design; Estimating and Costingò, New Age International (p) Limited, New Delhi
2. Surjit Singh, ñElectrical Estimating and Costingò, Dhanpat Rai and Company, New Delhi

7EP04 PROFESSIONAL ELECTIVE – III
(III) POWER SYSTEM OPERATION AND CONTROL

Course Outcomes: After successful completion of this course, students will be able to:

1. Summarise the knowledge of preliminaries on power system operation and control.
2. Determine the optimal scheduling of generation for a two-plant system with and without losses for the economic operation of the power system.
3. Develop the mathematical model of the Automatic Load-Frequency Control (ALFC) loop and the Automatic Voltage Regulator (AVR) loop.
4. Build the block diagram of two area system.
5. Explain the role of the power system stabilizer in damping the steady-state oscillations set up in the power system.

Unit I: Preliminaries on Power System Operation and Control: Power sector scenario in India: an overview, Players in the Indian power sector, Concept of grid: necessity and types of grids, Need of voltage and frequency control, Energy control centers (Load dispatch centers): Operation and functions, Levels of power system operation and control, SCADA: components and functions, Operating states of power system: normal state, alert state, emergency state, in extremis state and restorative state, State transition diagram showing various state transitions and control strategies.

Unit II: Economic Operation – Part I: Meaning of optimum scheduling, definition of unit, plant load and system load, UCP and LSP, Input ï Output characteristics, Heat rate characteristic, Incremental fuel rate, Incremental fuel cost, Reserve requirements: Installed reserves, spinning reserves, Cold reserves, Hot reserves, Methods of obtaining incremental fuel costs, Conditions for incremental loading, Optimum scheduling of generation between different units (Only two plant system without transmission loss).

A. Economic Operation – Part II: Transmission loss as a function of plant generation, Calculation of loss co-efficient (two plant system), Incremental transmission loss, Optimum scheduling of generation between different plants including transmission loss, Concept and significance of penalty factor.

Unit III: Generator Control Loops: Concept of real and reactive power, Effect of real and reactive power on system parameters, Philosophy of real and reactive power control, Basic generator control loops.

1. Automatic Voltage Regulator (AVR): Functions of AVR, Types of Exciters, Brushless AVR loop: Exciter modeling, Generator modeling, Transfer function block diagram representation, Static performance, dynamic response, Stability compensation, Effect of generator loading.

Unit IV: Automatic Load Frequency Control: Automatic generation control (AGC), Speed governing system, Transfer function modeling: Governor, Hydraulic valve actuator, Turbine, Generator, Load, Transfer function representation of an isolated generator, Static performance of speed governor, Closing of ALFC loop.

Unit V: Control Area: Meaning, Primary ALFC Loop: Static response, Dynamic response, physical interpretation of results, Secondary ALFC loop, Integral Control, Pool operation, Tie-line Modeling, Two area system ï Dynamic response, Tie-line bias control.

Unit VI: Steady-State Instabilities: Natural torsional oscillatory modes in power system, Natural mode of a single generator operating onto infinite bus, Effect of damper winding, Effect of changing excitation, Power system stabilizer, Introduction to modern control application, Introduction to power system security.

BOOKS RECOMMENDED:

Text Books:

1. O. L. Elgerd, ñElectric Energy Systems Theory: An Introductionò, Second edition, McGraw-HillBook Comp. N. Y. 1987.
2. J. Nagrath, D. P. Kothari, ñModern Power System Analysisò, Second edition, Tata Mc-Graw Hill Publishing Company, New Delhi.

Reference Books:

1. L. K. Kirchmayor, ñEconomic Operation of Power Systemò, Wiley Eastern Pvt. Ltd., New Delhi.
2. B. R. Gupta, ñGeneration of Electrical Energyò, S. Chand & Company Ltd.
3. P. S. R. Murty, ñPower System Operation and Controlò, Tata Mc-Graw Hill Publishing Company, New Delhi.
4. Wood and Wallenberg, ñPower Generation, Operation and Controlò, Willey Inter Science Publication.
5. Abhijit Chakrabarti, Sunita Halder, ñPower System Analysis Operation and Controlò, PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.

7EP05 PROFESSIONAL ELECTIVE – IV
(i)ARTIFICIAL INTELLIGENCE

Course Outcomes: After successful completion of this course, students will be able to:

1. To understand and communicate fundamentals of Artificial Neural Networks and Systems.
2. To understand and present various learning methods and architectures of neural network.
3. To understand and describe fuzzy logic and genetic algorithm fundamentals and be able to solve problems.
4. To apply AI techniques to solve electrical engineering problems along with inter disciplinary problems.

Unit I: Introduction: Biological Neurons and their artificial models, introduction to neural computing Components of neuron, input and output weight, threshold, weight factors, transfer Functions, concepts of supervised and unsupervised learning.

Unit II: Supervised Learning: Single Layer network, perceptron, Linear Separability, Training algorithm and limitations Multilayer Network: Architecture of feed forward network, learning rule, generalized Delta rule, learning function. Back propagation algorithm.

Unit III: Unsupervised Learning: Introduction, Counter propagation networks, Korhonenôs self-organizing maps, Hopfieldôs networks.

Unit IV: Introduction to Fuzzy: Uncertainty in information, basic concepts of Fuzzy sets, operations on fuzzy sets, properties. Fuzzy relations: operations, properties, value assignments.

Unit V: Membership Functions: Features, fuzzification, membership value assignments, Fuzzy Rule based Systems, Graphical technique of inference. De-fuzzification: Lambda-cuts for Fuzzy sets and Fuzzy relations, Defuzzification methods.

Unit VI: Genetic Algorithm (GA): Introduction to genetic algorithm, working principle, coding of variables, Fitness function. GA operators, similarities & differences between Gas and Traditional methods; Unconstrained and constrained optimization using Genetic Algorithm, real coded GA, Advanced GA, global optimization using GA.

BOOKS RECOMMENDED:

Text Books:

1. J.M. Zurada, ñIntroduction to Artificial Neural Networkò, Jaico Publishing House.
2. T J Ross, ñFuzzy Logic with Engineering Applicationò, Wiley Publication.

Reference Books:

1. G.J. Khir and T.A. Folger, ñFuzzy sets, Uncertainty and Informationò, PHI Publication.
2. KoskaBart, ñNeural Network & Fuzzy systemsò, Prentice Hall of India Pvt Ltd, NewDelhi.
3. MeherotraKishan, Mohan C.K., Ranka Sanjay, ñElements of Artificial Neural Networksò, Penram International Publishing (India) Pvt. Ltd.
4. D.E. Goldberg,ñGenetic Algorithm in Search Optimization and Machine Learningò, Addison-Wesley Longman Publishing Co., US.
5. Kalyanmoy Deb, ñOptimization for Engineering Design Algorithms and Examplesò, Prentice Hall of India, New Delhi.

7EP05 PROFESSIONAL ELECTIVE – IV
(ii) ELECTRICAL DRIVES& CONTROL

Course Outcomes: After successful completion of this course, students will be able to:

1. Explain the basic Concept of electrical drives
2. Demonstrate various modern speed, torque control techniques of DC drives
3. Demonstrate various modern speed, torque control techniques of AC drives

Unit I: Introduction to Electrical Drives: Overview of electrical drive, comparison of DC & AC drive, components of load torque. Stability of an electrical drive. Introduction to frame of references (synchronous and rotating), Park and Clark transformation.

Unit II: DC Drive Control: Introduction to Four quadrant operation of dc drive, reviewof principle of operation of the chopper, four quadrant chopper circuit operation. Steady state analysis of chopper-controlled DC motor drive: continuous and discontinuous current conduction. Closed loop speed controlled separately excited dc motor drive.

Unit III: AC Drive Control: Review of basic principle of operation, speed control of induction motor: Impact of rotor resistance of the induction motor torque--speed curve. Review of slip energy recovery scheme. Closed loop control of slip energy recovery-controlled induction motor drive. Power electronic based rotor side control of slip ring Induction motor.

Unit IV: Scalar Control of Induction Motor: overview of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation, voltage fed inverter control: open loop v/f control, close loop speed control with v/f control and slip regulation.

Unit V: Vector Controlled Drive: Review of DC drive analogy, equivalent circuit and phasor diagram, principles of vector control, direct or feedback vector control, flux vector estimation, indirect or feed forward vector control, vector control of line side PWM rectifier, stator flux-oriented vector control, vector control of current Fed inverter drive.

Unit VI: Direct Torque & Flux Control (DTC): Torque expression with stator & rotor fluxes, control strategy of DTC, Adaptive control: self-tuning control, Model Referencing adaptive control (MRAC), sliding mode control: Control Principle, sliding trajectory control of vector drive.

BOOKS RECOMMENDED:

Text Books:

1. Bimal K. Bose, ñModern Power Electronics and AC Driveò,Pearson Education.
2. Vedam Subrahmanyam, ñElectric Drives: Concepts & Applicationsò, Tata Mc Graw Hill Publishing Co Ltd.
3. Austin Hughes and Bill Drury,ñElectric Motor and Drives: Fundamentals, Types and Applicationsò, Newnes, Oxford.

Reference Books:

1. S.K.Pillai, ñA First Course on Electrical Drivesò, New Age International Publishing Co. Ltd.
2. Gopal. K. Dubey, ñFundamentals of Electrical Drivesò, CRC Press
3. R.Krishnan, ñElectric Motor Drives: Modeling, Analysis & Controlò, Prentice Hall of India Pvt. Ltd.
4. M.D. Singh & K.B. Khanchandani, ñPower Electronicsò, Tata Mc Graw Hill Publishing Co Ltd.
5. G. K. Dubey, ñPower Semiconductor Controlled Drivesò, Prentice Hall.
6. Dr. P. S. Bimbhra, ñGeneralized theory of Electrical Machineò, Khanna Publishers.

7EP05 PROFESSIONAL ELECTIVE – IV
(iii) DISTRIBUTION AUTOMATION

Course Outcomes: After successful completion of this course, students will be able to:

1. Summarize distribution system planning and automation.
2. Select appropriate communication technology for SCADA applied to distribution automation.
3. Demonstrate the knowledge of substation automation.
4. Improve the voltage profile of distribution feeder using distribution automation.
5. Explain the concept of remote metering.
6. Choose the appropriate type of energy management.

Unit I: Distribution System Planning and Automation: Power Sector Reforms, Basic Distribution Systems, Short-Term Load Forecasting, Long-Term Energy Forecasting, Technological Forecasting, Problems with existing Distribution System, Need for Distribution Automation, Characteristics of Distribution System, Distribution Automation (Objectives, Functions, Benefits), Basic architecture of Distribution automation system, Feeder Automation, Communication Requirements for DA, Remote Terminal Unit (RTU), Communication Technologies for DA.

Unit II: SCADA-Control and Communication: Introduction, Block Diagram, Components of SCADA, Functions of SCADA, SCADA applied to Distribution Automation, Advantages of DA through SCADA, Requirements and Feasibility, DA Integration Mechanisms, Communication Protocols in SCADA Systems.

Unit III: Substation Automation: Introduction, Definition of Substation Automation, Benefits of Substation Automation, Functions of Substation Automation System, State and Trends of Substation Automation, Intelligent Affordable Substation Monitoring and Control, Advantages of an EEM (Enterprise Energy Management) Substation Automation Solution.

Unit IV: Feeder Automation: Losses in Distribution Systems, System Losses and Loss Reduction, Network Reconfiguration, Improvement in Voltage Profile, Capacitor Placement in Distribution System for Reactive Power Compensation, Algorithm for location of capacitor.

Unit V: Remote Metering: Background of Remote Metering, Components of AMR Systems, Communications Methods used for Meter Reading, AMR System, Services and Functions, Financial Analysis, Planning for AMR Implementation.

Unit VI: Energy Management: Energy Management, Need Based Energy Management (NBEM), Demand Side Management (DSM), Maintenance of Automated Distribution Systems, Difficulties in Implementing Distribution Automation in Actual Practice, Urban/Rural Distribution.

BOOKS RECOMMENDED:

Text Book:

Dr. M. K. Khedkar and Dr. G. M. Dhole, ñA Textbook of Electric Power Distribution Automationò, University Science Press (Laxmi Publications Pvt. Ltd.), 2011.

Reference Books:

1. Bassett, K. Clinard, J. Grainger, S. Purucker, and D. Ward, ñTutorial Course: Distribution Automationò, IEEE Tutorial Publication 88EH0280-8-PWR, 1988.
1. James Northcote-Green, Robert Wilson, ñControl and Automation of Electrical Power Distribution Systemsò CRC Press, Taylor and Francis Group, 2007
2. James A. Momoh, ñElectric Power Distribution, Automation, Protection, and Controlò, CRC Press, Taylor and Francis Group, 2007
3. S. Sivanagaraju, V. Sankar, ñElectrical Power Distribution and Automationò, Dhanpat Rai and Co, 2006.

7EP06 POWER SYSTEM II – LAB.

Student should perform minimum eight (8) practicals based on syllabus**.**

List of Experiments:

1. Determination of Xd and Xq by slip test.
2. Determination of Xdô and Xdôô by sudden symmetrical short circuit test.
3. Determination of Xdôô and Xqôô by conducting static test.
4. Determination of X1, X2 and Xo by conducting direct test.
5. Determination of X1, X2 and Xo by conducting In-direct test.
6. Symmetrical Component Analysis of Unbalanced Three Phase Vector.
7. Symmetrical and Unsymmetrical Fault Analysis
8. Improvement transient stability using Facts Devices.
9. Power System Stability improvement using STATCOM.
10. Solution of swing equation using Point by Point Method.
11. Solution of swing equation using by Runge-Kutta method.
12. To Study Equal Area Criteria for transient stability.
13. To Study abc to dq0 (Parks) Transformation.
14. Transient stability analysis of a multi-machine power system.

7 EP07 DIGITAL SIGNAL PROCESSING – LAB.

Student will carry out minimum eight (8) assignments based on syllabus. List of experiments is given below for reference.

List of Experiments:

1. To generate various continuous and discrete signals.
2. To verify sampling theorem.
3. To find linear convolution of given sequences.
4. To compute auto-correlation between two sequences.
5. To find impulse response of given system.
6. To find DFT and IDFT of given sequence.
7. To find FFT of a given sequence.
8. To determine power spectrum of a given signal.
9. To find frequency response of a given system.
10. To design and implement FIR filter for given specifications.
11. To implement LP FIR filter for a given sequence.
12. To implement HP FIR filter for a given sequence.
13. To implement LP IIR filter for a given sequence.
14. To implement HP IIR filter for a given sequence.
15. To generate a sinusoidal signal through filtering.
16. To plot magnitude and phase response of digital butter worth low pass and high pass filter.
17. To perform implementation of I/D sampling rate converter.

7EP08 ENTREPRENEURSHIP & PROJECT MANAGEMENT –LAB.

Student will carry out minimum eight (8) assignments based on syllabus. List of assignments is given below for reference.

List of Assignments:

1. Undertake SWOT analysis to arrive at your business idea (Product / services).
2. Undertake self-assessment test to discover your Entrepreneurial traits.
3. Undertake the market survey to identify the need of market.
4. Identify Business opportunity for you.
5. Carry out the survey of industries of your stream and prepare the report.
6. Arrange the Visit to industries/firms of your product/service stream to study their business model.
7. Visit the banks and other financial Institutions to enquire about various funding scheme for set up the new business.
8. Compile the information of government agencies and financial agencies which provide loan/financial support to establish the business.
9. Prepare a report of technological and financial feasibility of chosen product/service.
10. Prepare a marketing strategy for chosen product/service.
11. Prepare a short term &long-term goal of your business.
12. Prepare a business plan for your chosen product/services.
13. Arrange a discussion session with successful entrepreneur to discuss on your business plan.
14. Study the stories of successful entrepreneur.
15. Prepare a DPR (Detail Project Report) of chosen product /services.

7EP09 PROJECT & SEMINAR

Seminar:
Each one of the students will be assigned a Seminar Topic in the current and frontier areas. The student has to conduct a detailed study/survey on the assigned topic and prepare a report. The student will make an oral presentation followed by a brief question and answer session. The Seminar (presentation and report) will be evaluated by an internal assessment committee for 50 marks.

Project:
The objective of the project is to enable the students to work in groups of not more than six members in each group on a project involving analytical, experimental, design or combination of these in the area of Electrical Engineering. Each project shall have a guide. The student is required to do literature survey, formulate the problem and form a methodology of arriving at the solution of the problem. On completion of the work, a project report should be prepared and submitted to the department. The evaluation is based on continuous internal assessment by an internal assessment committee for 75 marks. The university examination, which carries a total of 75 marks, will be a Viva Voce examination at the end of VIII Semester, conducted by a committee of one external examiner appointed by the University and one internal examiner/Guide.

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SEMESTER EIGHTH

8EP01 POWER SYSTEM PROTECTION

Course Outcomes: After successful completion of this course, the students will be able to:

1. Explain the need, desirable features & main components of protection system.
2. Design the various protection scheme for transmission line
3. Develop the protection scheme for Alternator, Transformer, Motors & Busbar
4. Demonstrate the knowledge of static relays & Numerical relays
5. Select the proper type & rating of circuit breaker and fuses for various application.

Unit I: Fundamentals of Power System Protection: Importance & need of protection system, faults statistics, Desirable features, CTôs and PTôs for protection circuit, Relay classification. Basic terminology, Construction, operation, characteristics and application of Over-current relay, Directional relay, Distance relay and Differential relays.

Unit II: Protection of Transmission Line: Protection of radial feeder, parallel feeder, and ring main distribution system using over current relay, Combine OC & EF protection system, Distance protection of transmission line, three stepped protection, differential protection using pilot wire, translay system, carrier current protection for EHV line. Power swing, Auto-reclosure.

Unit III: Protection of Power System Equipment's: Alternator Protection: Protection system against failure of prime mover, failure of excitation system, over-speed, overvoltage, unbalanced loading, overloading, stator winding faults & rotor earth fault.
Transformer Protection: Over current protection, Merz Price Protection, Buchholz relay, restricted earth fault protection, Protection against Over-fluxing.
Motor Protection: Faults on Motor, Protection against single phasing, overloading, stator winding faults, locked rotor, bearing failure, phase reversal.
Bus-bar Protection: types of bus-bar arrangement, differential protection, Frame leakage protection.

Unit IV: Static & Numerical relays: Static Relay: General block diagram of static relay, merits & demerits of static relay over electromechanical relay, static over-current, directional, differential and distance relay.
Numerical relay: Numerical relaying fundamentals, block diagram, merits & demerits of numerical relay. Digital Protection scheme for alternator, transformer & Motor.

Unit V: Fuses: Construction, operation & application of HRC fuses, Basic terminology, HV fuses.
Circuit breaker: Basic principle of operation, arc phenomenon, arc interruption methods, arc voltage and current waveform in AC circuit breaking, re-striking and recovery voltage, Inductive and Capacitive current interruptions, current chopping, ratings of circuit breakers.

Unit VI: Circuit Breakers: Construction, operation and important features of oil CB, minimum oil CB, air blast CB, vacuum CB and SF6 CB, Testing, Installation & Maintenance of CB., auto high-speed re-closing. Construction, working and application of MCB, MCCB, ELCB & RCCB.

BOOKS RECOMMENDED:

Text Books:

1. Badri Ram and B. N. Vishwkarma, ñPower System Protection and Switchgearò, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
2. Y. G. Paithankar& S. R. Bhide, ñFundamentals of Power System Protectionò, PHI Publication, Delhi.

Reference Books:

1. Sunil S. Rao, ñSwitchgear and Protectionò, Khanna Publications, New Delhi
2. S R Bhide, ñDigital Power System Protectionò, PHI Publication, New Delhi.
3. C. R. Mason, ñThe Art and Science of Protective Relayingò, **4Th Edition by Blackburn J L, Taylor & Francis Exclusive (Cbs)**
4. R. Van and C. Warringtan, ñProtective Relayingò, Vol 1 and 2, Chapman Hall, London.
5. B. Ravindranath and M. Chander, ñPower System Protection and Switchgearò, Wiley Eastern Ltd, New Delhi.
6. A G. Phadke and J. S. Thorp, ñComputer Relaying for Power Systemsò, Research Studies Press Ltd., England John Wiley & sons Inc., New York.
7. R. T. Lythall, ñSwitchgear Handbookò, J and P Newness Butterworth, London.

8EP02 COMPUTER METHODS IN POWER SYSTEM ANALYSIS

Course Outcomes: After successful completion of this course, the students will be able to:

1. Develop mathematical model to represent the power system components for computerized analysis.
2. Demonstrate the topology of electrical power system.
3. Formulate Z_{bus} & Y_{bus} by algorithm.
4. Analyze short circuit studies of electrical power system.
5. Analyze load flow studies of electrical power system.
6. Examine stability studies of electrical power system.

Unit I: Representation of Power system for Computerized Analysis: Mathematical model of synchronous generator for steady state and transient analysis. Representation of Induction motor, Fixed tap setting transformer, Phase shifting transformer, On Load Tap Changer, transmission line & loads.

Unit II: Topology of Electrical Power System: Introduction to frame of references (bus, branch and loop), graph theoretic approach: Incidence Matrices: element node, bus incidence, branch path, basic cut set, augmented cut set, basic loop, augmented loop. Representation of Primitive network in impedance & admittance form, formation of network matrices by singular & non-singular transformation.

Unit III: Formation of Z_{bus} & Y_{bus} by Algorithm: Development of Z_{bus} &Y_{bus} by step-by-step algorithm on account for changes in network (addition of branch and link). Derivation of Z_{loop} matrix. Transformation matrix- incidence & network matrices for three phase networks. Three phase balanced network elements: Balanced & unbalanced excitation. Clark component transformation. Algorithm for formulation of three phase bus impedance (Z_{bus}) matrix.

Unit IV: Short Circuit Studies: Need, assumptions for short circuit analysis, three phase networks representation, symmetrical components, Theveninôs theorem and short circuit analysis using Z_{bus} matrix, Algorithm for calculation of System conditions, short circuit calculations for balanced three phase networks using Z_{bus} matrix: Transforming to symmetrical components.

Unit V: Load Flow Studies: Network performance equation, line flow equation and bus loading equation. Classification of buses. Formation of load flow problem by using Gauss- Seidel and Newton-Raphson method (Polar & Rectangular), decoupled load flow and Fast Decoupled methods of power flow, sparse Matrices.

Unit VI: Stability Studies of Power system: Development of mathematical model for multi-machine system stability analysis-Formation of equations and methods of solutions. Transient stability analysis including synchronous machines, system networks and loads. Solution of state equation by modified Euler method and Runge Kutta forth order approximation method.

BOOKS RECOMMENDED:

Text Books:

1. G.W.Stagg &Ahmed H. Eiï Abaid, ñComputer Methods in Power System Analysisò, Mc Graw Hill Book Co. Ltd.
2. M.A.Pai, ñComputer Techniques in Power System Analysisò, Tata Mc Graw Hill Publishing Co. Ltd.

Reference Books:

1. L.P.Singh, ñAdvanced Power System analysis and Dynamicsò, New Academic Science
2. R.N.Dhar, ñComputer Aided Power System Operation and Analysis of Power Systemò, Mc Graw Hill Co. Ltd.
3. I.J.Nagrath and D.P.Kothari, ñModern Power System Analysisò, Tata Mc Graw Hill Publishing Co. Ltd.

8EP03 PROFESSIONAL ELECTIVE-V
(i) HIGH VOLTAGE ENGINEERING

Course Outcomes: After successful completion of this course, students will be able to:

1. Explain the breakdown mechanism in solid, liquid, and gaseous dielectrics.
2. Select an appropriate protective device to protect the power system against overvoltageôs caused by internal and external causes.
3. Utilize different circuits used for the generation of high AC, DC, and impulse voltages.
4. Measure high AC, DC, and impulse voltages.
5. Test the insulation of various high voltage apparatus used in the power system.

Unit I :

Breakdown in Gases: Breakdown in Gases, Insulating materials Classification, Gases as insulating media, Ionization and decay process, Breakdown in gases, Townsendôs law, Streamer mechanism of spark, Paschenôs law, Corona discharge, Electronegative gases.

Unit II:

Breakdown in Liquid & Solid Dielectrics: Breakdown in Liquid and Solid Dielectrics, Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, High voltage bushings, Guarding, Shielding, Field plotting.

Unit III:

Over Voltages in Electrical Power System: Lightning and Switching Over Voltage and Protection, Lightning strokes to lines and towers, Mechanism, Characteristics and protection of transmission lines from lightning, Lightning arrestors, Metal oxide arrestor, Insulation coordination of HV and EHV power system and substation.

Unit IV:

Generation of High Voltages & Impulse Voltages: High Voltage and Current Generation, Generation of high DC, AC and impulse voltages, Standard impulse wave shapes, Switching surges, and High impulse generator.

Unit V:
Measurement of High Voltages & Impulse Voltages: High Voltage and Current Measurement Peak voltage, Impulse voltage and High direct measurement methods, Non-destructive measurement, High voltage dielectrics loss and capacitance measurement, Radio frequency and Partial discharge measurement.

Unit VI:
High Voltage Testing: Basic terminology, High voltage testing of electrical power apparatus as per International and Indian standards - Insulators, Bushings, Cables, Transformers, Surge diverters and Isolators, Electric shock and threshold current, Capacitance of long objects, Electromagnetic interference.

BOOKS RECOMMENDED:

Text Book: M. S. Naidu and V. Kamraju, ñHigh Voltage Engineeringò, Tata McGraw Hill Publishing, Company, New Delhi.

Reference Books:

1. E. Kuffel and W. S. Zaenglo, ñHigh Voltage Engineeringò, Pergamon Press.
2. Rokosh Das Begamudre, ñEHV AC. Transmission Engineeringò, Wiley Easter Ltd. New Delhi.
3. E. Kuffel and M. Abdullaha, ñHigh Voltage Engineeringò, Pergamon Press.
4. M. S. Naidu and V. N. Maller, ñSF6 and Vacuum Insulation for High Voltage Applicationò, Khanna Publications, Delhi.
5. Subir Ray, ñAn Introduction to High Voltage Engineeringò, Prentice ï Hall & India, Private Limited, New Delhi.C.L. Wadhawa, ñHigh Voltage Engineeringò, New Age international (P) Ltd. Publications.

8EP03 : PROFESSIONAL ELECTIVE- V
(ii) HVDC and FACTS

Course Outcomes: After successful completion of this course, students will be able to:

1. Discuss different components of HVDC transmission system.
2. Explain the operation and control of HVDC converters.
3. Identify the suitable reactive power compensation technique and filter for HVDC system.
4. Choose proper FACTS controller for the specific application based on system requirements.
5. Analyze the circuits of static shunt and static series compensators used for the prevention of voltage instability and improvement of transient stability and power damping oscillations.
6. Demonstrate the knowledge of Unified power flow controller (UPFC).

Unit I:
Introduction to HVDC:HVDC Transmission Basic principle, Need for HVDC, Comparison of AC and DC transmission systems, Advantages and Disadvantages of HVDC Systems, Application of HVDC transmission, Types of HVDC links, Layout of HVDC converter station and various equipmentôs, Planning for HVDC transmission, Modern trends in HVDC transmission.

Unit II:
HVDC Converters: Choice of converter configuration, types of converters, 6 - pulse and 12- pulse converters, Analysis of Graetz circuit with and without overlap, Principles of DC Link Control, Converters Control Characteristics, System control hierarchy, firing angle control, Constant current (CC) and Constant extinction angle (CEA) control, Starting and stopping of DC link, DC smoothing reactors.

Unit III:
Reactive Power Compensation, Harmonics and Filters : Reactive Power Requirements in steady state, sources of reactive power, Synchronous condensors, Generation of harmonics, AC and DC filters, Introduction to multi-terminal DC systems.

Unit IV:
Introduction to FACTS: Transmission Inter connections, Opportunities for FACTS, Flow of power in an AC system, Power flow in parallel paths, Power flow in meshed systems, loading capability limits, Control of Power Flow in AC Transmission Line, Reactive power compensation, Basic types of FACTS controllers, Brief description and definitions of FACTS controllers, Shunt connected controllers, Series connected controllers, Combined Shunt and Series Connected Controllers, Benefits of using FACTS technology.

Unit V:
Static Shunt Compensators: Objectives of Shunt Compensation - Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of Transient Stability, Improvement of Power Damping Oscillations, Methods of Controllable Var Generation - Thyristor controlled Reactor (TCR) and Thyristor Switched Reactor (TSR), Thyristor Switched Capacitor (TSC), Fixed Capacitor - Thyristor Controlled Reactor (FC-TCR), Static VAR Compensator (SVC) and Static Synchronous Compensator (STATCOM), Comparison between SVC and STATCOM, V-I and V-Q Characteristics of SVC and STATCOM.

Static Series Compensators: Concept of Series Capacitive Compensation, Objectives of Series Compensation, Voltage Stability, Improvement of Transient Stability, Power Oscillations Damping, Sub-synchronous Oscillation Damping,Variable Impedance Type Series Compensators -Thyristor Controlled Series Capacitor (TCSC), Switching Converter Type Series Compensators -Static Synchronous Series Compensator (SSSC).

Unit VI:

Power Flow Controllers: Unified power flow controller (UPFC) ï Introduction, operating principle, independent real and reactive power flow controller and control structure. Comparison between UPSC and Controlled Series Compensator, Interline power flow controller (IPFC).

BOOKS RECOMMENDED:

Text Books:

1. K.R. Padiyar, ñHVDC Power Transmission Systems: Technology and system Interactionsò, New Age Publishers, Third *Edition,* 2017.
2. Narain G. Hingorani&LaszloGyugyi, ñUnderstanding FACTS: Concepts and Technology of Flexible AC Transmission Systemsò, Wiley India Pvt Ltd,2011.

Reference Books:

1. S. Kamakshaiah, V. Kamaraju, ñHVDC Transmissionò, McGraw Hill Education, 2017.
2. Kimbark, E.W., ñDirect current transmissionò, Vol.1, Wiley Interscience, New York, 1971.
3. Arrilaga, J., ñHigh Voltage Direct current transmissionò, Peter Peregrinus Ltd., London, UK.,1983.
4. Vijay K. Sood, ñHVDC and FACTS Controllers Applications of Static Converters in Power Systemsò, Kluwer Academic Publishers, 2004.
5. Enrique Acha, ñFACTS: Modeling and Simulation in Power Networksò, Wiley India Pvt. Ltd., 2012.
6. R. Mohan Mathur, Rajiv K. Varma, ñThyristor Based FACTS Controllers for Electrical Transmission Systemsò, Wiley Inter-science, 1st Edition, 2002.

8EP03 PROFESSIONAL ELECTIVE- V
(iii) SMART GRID SYSTEM

Course Outcomes: After successful completion of the course, students will be able to:

1. Explain the features, necessity and architecture of Smart Grid.
2. Relate the role of Automation in Transmission and Distribution.
3. Decide different measuring methods and sensors used in Smart Grid.
4. Interpret the role of batteries and energy storages in Smart Grid.
5. Discuss Power Quality issues in Smart Grid.
6. Elaborate the role of communication and networking in Smart Grid.

UNIT I: Introduction to Smart Grid: Evolution of Electric Grid, Smart Grid Concept - Definitions and Need for Smart Grid ï Functions ï Opportunities - Benefits and challenges, Difference between conventional & Smart Grid.

UNIT II: Smart Grid Architecture and Automation: Components and Architecture of Smart Grid, Fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation, Renewable Integration

UNIT III: Sensors and Measurement: Sensors for Smart Grid, Monitoring and Measurement Technologies, Phase Measurement Unit (PMU), Smart meters, Smart Appliances, Multi Agent Systems (MAS) Technology, Micro grid and Smart grid comparison, Wide Area Measurement

UNIT IV: Smart Substation and Energy Storage: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, Superconducting Magnetic Energy Storage, Super Capacitors, Flywheel, Pumped Hydro Storage, Compressed Air Energy Storage.

UNIT V: Power Quality Management in Smart Grid: Power Quality & Electromagnetic Compatibility (EMC) in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT VI: Communication Technologies and Smart Grid: Elements of communication and networking ï architectures, standards, PLC, Zigbee, GSM, Local Area Network (LAN) - House Area Network (HAN) - Wide Area Network (WAN) - Broadband over Power line (BPL) - IP based Protocols - Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid

BOOKS RECOMMENDED:

Text Books:

1. Stuart Borlase, ñSmart Grid: Infrastructure, Technology and Solutionsò, CRC Press 2012
2. A.G. Phadke and J.S. Thorp, ñSynchronized Phasor Measurements and their Applicationsò, Springer Edition, 2010.

Reference Books:

1. Stephen F. Bush, ñCommunication-Enabled Intelligence for the Electric Power Gridò, Wiley-IEEE.
2. James Momoh, ñSmart Grid: Fundamentals of design and analysisò, John Wiley & sons Inc, IEEE Press, 2012.

8EP04 PROFESSIONAL ELECTIVE - VI
(i) POWER QUALITY

Course Outcomes: After successful completion of this course, students will be able to:

1. Illustrate the concept, need, and standards of Power Quality.
2. Classify Power quality characteristics.
3. Select power conditioning device for mitigation of power quality problem.
4. Make use of measurement tools for power quality survey.

Unit I: Introduction: Power Quality Definition. Need for Power Quality, Sensitive Loads, Nonlinear Loads, Interconnected Power System, Deregulation and its Effect, Stakeholders of Power Quality and their Role.

Unit II: Power Quality Characteristics: Power Quality Theory, Types of power Quality Problems, Voltage Swells, Long-Duration Over voltages, Under voltages, Interruptions, Transients, Voltage Unbalance, Voltage Fluctuations, Harmonics, Electrical Noise, Sources and Effects of Power Quality Problems, Power Quality Problem-Solving Procedures.

Unit III: Power Quality Standards: Power Quality Standardsô Organizations, Institute of Electrical & Electronics Engineers (IEEE), American National Standards institute (ANSI), International Electro technical Commission (IEC) Other International Standards Organizations, Purpose of Power Quality Standards, ôTypes of Power Quality Standards, Voltage Sag (Dip) Standards, Transients, Voltage Unbalance, Voltage Fluctuation or Flicker Standards, Harmonics Standards, Transformer Overheating Standards, Natural Conductor Loading Standards, Static Electricity, Telephone Power Quality Standards, Grounding and Wiring Standards, Sensitive Electronics Equipment Standards, Trends in Power Quality Standards.

Unit IV: Power Quality Solutions: Reduce Effects on Sensitive Equipment, Reduce or Eliminate Cause, Reduce or Eliminate Transfer Medium, Install Power Conditioning Equipment, Surge Suppressors, Noise Filters, Isolation Transformers, Line-Voltage Regulators, Motor-Generator Sets, Magnetic Synthesizers Uninterruptible Power Supply (UPS), Solid-State Switches, Harmonics Solutions, Construction and Working Principle of Shunt Active Power Filter, Series Active Power Filter and Unified Power Quality Conditioner, Selection of Appropriate Power Conditioning Equipment.

Unit V: Wiring and Grounding: Wiring and Grounding Principles, Utility Power System Grounding, Telecommunication System Grounding, End-User Power System Grounding, Wiring and Grounding Problems, Ground Loops, Electromagnetic Interference (EMI) Noise, Loose Connections, Grounding for Lightning and Static Electricity, Wiring Solutions: Separation, Selection of Wire and Cables, Shielding Grounding Solutions: Ground Rods, Ground Ring, Ground and Reference Signal Grids, Other Grounding Systems, Isolated Grounds, Multipoint Grounding, Separately Derived Source Grounding.

Unit VI: Power Quality Measurement Tools & Power Quality Surveys: Factors considered for selection of measurement tools, Kilowatt-Hour Meter, Multimeters, Average-responding versus True RMS Meters, Current Probes, Oscilloscope, Disturbance Analyzer, Harmonics Analyzer, Power Quality Analyzer Purpose of a Power Quality Surveys, planning a power Quality Survey.

BOOKS RECOMMENDED:

Text Book: Roger C Dugan, Santoso & McGranahan, ñElectrical Power Systems Qualityò, McGraw Hill.

Reference Books:

1. G.T. Heydt, ñElectric Power Qualityò, Stars in a circle Publication, Indiana, 1991.
2. Barry W. Kennedy, ñPower Quality Primerò, McGraw-Hill.
3. Alexander Kusko, ñPower Quality in Electrical Systemsò, McGraw-Hill.
4. Bhim Singh,Ambrish Chandra,Kamal Al-Hadad, ñPower Quality Problems and Mitigation Techniquesò, Wiley Publication.

8EP04 PROFESSIONAL ELECTIVE – VI
(ii) ELECTRICAL ENERGY CONSERVATION AND AUDITING

Course Outcomes: After successful completion of this course, students will be able to:

1. Summarize Indian and global energy scenario.
2. Explain types of energy Audit and its procedure.
3. Discuss economics of energy conservation
4. Elaborate the concepts of energy conservation and management.
5. Choose Appropriate energy efficient techniques for energy conservation
6. Apply the understanding of energy conservation and management for industrial applications.

Unit I: Energy Scenario: Various forms of energy: Primary and secondary energy, commercial and non-commercial energy, renewable and non-renewable. Indian and global energy scenario, energy needs of growing economy, energy pricing, electricity billing and tariff. Energy sector reforms: In coal, oil, natural gas and electricity. Functions and Responsibilities of CERC & SERC. Energy Conservation Act-2001, Indian electricity Act 2003 and its features. Electricity (Amendment) Bill, 2020 ï Key Highlights. Energy and environmental Impacts.

Unit II: Energy Audit: Definition, energy audit, need, types of energy audit: Preliminary and detailed energy audit. Energy audit instruments. Procedure for carrying out energy audit. Data Analysis-Energy production relationship, specific energy consumption, Sankey (energy flow) diagram, CUSUM Technique, Bench marking, energy performance.

Unit III: Economics of Energy conservation: Cost factors, Budgeting, Standard costing and Sources of capital, Cash flow diagram and activity chart, Simple Payback period analysis, Time value of money, Net present value method, and internal rate of return method. Profitability index for benefit cost ratio.

Unit IV: Energy Conservation & Management: Definition and necessity of energy conservation. Review of electric motors, types, losses, motor efficiency, factors affecting motor Performance, transformer types & its losses. Rewinding and motor replacement issues. Definition and Objective of Energy Management, concept of Supply Side Management (SSM) and Demand Side Management (DSM), methods of implementing demand side management and advantages to consumer, utility and society. Energy strategy for the future.

Unit V: Energy Efficient Techniques in Electrical Systems: Review of power factor improvement and its benefit, selection and location of capacitors. Power factor penalties and incentives in tariff for demand control. Recommendations for energy conservation: Maximum demand controllers, automatic power factor controllers, Variable Speed Drives, Energy efficient transformers. Soft starting of motors.

Unit VI: Energy Conservation in Industrial Applications: Energy conservation opportunities in motive power (Motors and drive system)- Energy efficient motors, Heating Ventilation and Air Conditioning(HVAC), Illumination system, Pumps and Pumping systems, thermal power stations, Utility Industries: Transmission & Distribution Sector. Cogeneration &Waste heat recovery systems. Energy Audit Case Study of energy intensive industry.

BOOKS RECOMMENDED:

Text Books:

1. ñEnergy Audit and Conservationò, TERI.
2. S. C. Tripathy, ñUtilization of Electrical Energy and Conservationò, Mc.Graw Hill, 1991.

Reference Books:

1. ñSuccess stories of Energy Conservationò, BEE, New Delhi. (www.beeindia.gov.in)
2. Thumman, ñEnergy Conservation and Auditò, Fairmont Press.
3. SonalDesai, ñHandbook of Energy Auditò, Mc. Graw Hill.
4. Guide books for National Certification Examination for Energy Manager/Energy.
5. Auditors Books, General Aspects (available online).

8EP04 PROFESSIONAL ELECTIVE – VI
(iii) ELECTRIC AND HYBRID VEHICLES

Course Outcomes: After successful completion of this course, students will be able to:

1. Understand the models to describe hybrid vehicles and their performance.
2. Understand the different possible ways of energy storage.
3. Understand the different strategies related to energy storage systems.

Unit I: Introduction: Conventional Vehicles: Basics of vehicle performance, vehicle power source Characterization, transmission characteristics, mathematical models to describe vehicle performance.

Unit II: Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Unit III: **Hybrid Electric Drive**: Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Unit IV: Electric Trains: Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit V: Energy Storage: Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

Unit VI: Energy Management Strategies: Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

BOOKS RECOMMENDED:

Text Books:

1. C. Mi, M. A. Masrur and D. W. Gao, ñHybrid Electric Vehicles: Principles and Applications with Practical Perspectivesò, John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, ñHybrid Electric Vehicles: Energy Management Strategiesò, Springer, 2015.

Reference Books:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, ñModern Electric, Hybrid Electric, and FuelCell Vehicles: Fundamentals, Theory, and Designò, CRC Press, 2004.
2. T. Denton, ñElectric and Hybrid Vehiclesò, Routledge, 2016.

8EP05 POWER SYSTEM PROTECTION – LAB.

Student will perform minimum 08 experiment based on syllabus of Power System Protection. List of experiment is given below for reference.

List of Experiments:

1. Development of control circuit for power supply control of three phase IM.
2. Development of control circuit for direction control of three phase IM.
3. Polarity test & ratio test on CTs & PTs.
4. Plot the characteristics of Inverse Time OC relay.
5. Plot the characteristics of Differential relay.
6. Plot the operating characteristics of MCB & fuses.
7. Plot the characteristics of impedance relay or MHO relay.
8. Develop the combine OC & EF protection scheme for three phase alternators.
9. Develop the protection system for alternator against unbalanced loading.
10. Develop the Merz Price Protection scheme for three phase transformers.
11. Develop the protection system for three phase IM against single phasing.
12. Develop the static over-current relay.
13. Demonstrate Operation of static overvoltage & under voltage relay.
14. Study the protection scheme for three phase IM using microprocessor-based relays.
15. Demonstration of numerical relays.

8EP06: COMPUTER METHODS IN POWER SYSTEM ANALYSIS – LAB.

Student should perform minimum eight (8) practicals based on the syllabus .

List of Experiments:

1. Write a Program for formation of Bus Admittance Matrix (Ybus) for a given Power System network using Singular Transformation.
2. Write a Program for formation of Bus Impedance Matrix (Zbus) for a given Power System network by step-by-step Algorithm.
3. Write a Program for Short circuit Analysis when three phase to ground fault at bus P of a given Power System network.
4. Write a Program for Short circuit Analysis when three phase faults at bus P of a given Power System network.
5. To determine fault voltage and fault current when three phase faults at bus P of a given power system network by using simulation software.
6. To determine fault voltage and fault current when three phase to ground fault at bus P of a given power system network by using simulation software.
7. Write a program for load flow studies on a given power system network by Gauss- Seidel method using bus Admittance Matrix (Ybus).
8. Write a program for load Flow studies on a given power system network by Newton-Raphson method in Polar Coordinates by using bus Admittance Matrix (Ybus).
9. Write a program for load flow analysis on a given power system network using Fast Decoupled Load Flow (FDLF) Method.
10. To find the critical clearing angle when three phase fault occurs at sending end of transmission line of a given power system network by using simulation software.
11. To find the critical clearing angle when three phase fault occurs at mid-point of transmission line of a given power system network by using simulation software.
12. To plot swing curve of a given power system by using simulation software.
13. To study load flow analysis of a power system by using *Gauss-Seidel, Newton*-Raphson and FDLF Methods.
14. To study short circuit analysis of a Power system network.
15. To study Modified Euler method and Runge Kutta 4^{th} order Approximation Methods for stability studies of a Power System network.

8EP07 PROJECT & SEMINAR

Seminar:
Each one of the students will be assigned a Seminar Topic in the current and frontier areas. The student has to conduct a detailed study/survey on the assigned topic and prepare a report. The student will make an oral presentation followed by a brief question and answer session. The Seminar (presentation and report) will be evaluated by an internal assessment committee for 50 marks.

Project:
The objective of the project is to enable the students to work in groups of not more than six members in each group on a project involving analytical, experimental, design or combination of these in the area of Electrical Engineering. Each project shall have a guide. The student is required to do literature survey, formulate the problem and form a methodology of arriving at the solution of the problem. On completion of the work, a project report should be prepared and submitted to the department. The evaluation is based on continuous internal assessment by an internal assessment committee for 75 marks. The university examination, which carries a total of 75 marks, will be a Viva Voce examination at the end of VIII Semester, conducted by a committee of one external examiner appointed by the University and one internal examiner/Guide.

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